Ministry of Energy
Ontario

Energy Ontario

Coal in Ontario

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Executive Summary

This report details the basic features of coal supply and consumption in Ontario and elaborates on the outline presented in the Coal Update section of the *Ontario Energy Review.*

Consumption

Ontario accounts for 51 per cent of total Canadian coal consumption and for almost all Canadian coal imports. Fifty-six per cent of Ontario's coal consumption is used by Ontario Hydro in the thermal generation of electricity. Forty-one per cent consists of higher-grade metallurgical coal being converted to coke for steel-making by Stelco, Dofasco, and Algoma Steel. The remaining three per cent (down drastically from 39 per cent in 1965) is used for space and process heating in the industrial, commercial, and residential sectors.

Future trends in consumption will be influenced by a number of contradictory technological and demand factors, which are discussed briefly. Coal's competitiveness with other fuels is impaired by such problems as its relative uncleanliness, handling difficulties, and the land use costs it entails.

Supply

Ontario produces no coal. About 87 per cent of its consumption is supplied from the Appalachian region of the United States with the remaining 13 per cent from Western Canada and the Maritimes; a result of diversification since the early 1970s from almost total reliance on U.S. coal. Pressure from the U.S. steel industry and utilities (for secure supplies of higher grades of coal) combined with the new U.S. energy policies, seemed several years ago to have the potential for restricting the capability of meeting the forecast growth in Ontario's demand for coal from U.S. sources alone. However, reduced growth in U.S. industry, in U.S. electrical demand, in Ontario Hydro's own need for coal, as well as political delays to President Carter's energy initiatives, have altered this situation. As a result, Ontario no longer faces any immediate coal supply constraints.

Transportation costs cause Western Canadian coal shipped to Ontario to be 40 to 50 per cent more expensive than Appalachian coal on a kJ* basis. Nova Scotian coal is similar enough in quality to U.S. supplies to be a substitute in Ontario. However, while shipping from the Maritimes is less expensive than movement by train from the West, production facilities for Nova Scotian coal of consistent quality and reliable long-term quantities are limited.

Much of the U.S. coal purchased by Ontario Hydro and the province's steel mills is mined on long-term contracts or from partly owned or dedicated mines. The contracts contain sufficient flexibility so that quantities can be adjusted to accommodate additional Canadian coal, such as that from Nova Scotia. But only if it is economically available and considered a desirable strategy.

*Kilojoule: 1.055 kilojoules = 1 British thermal unit (BTU)

Ontario's only known coal deposit, at Onakawana near James Bay, is low-quality lignite and is not large by North American standards. It is, however, large enough to sustain approximately 1,000 MW of electrical capacity. A mine-mouth electrical generating station is presently being evaluated.

Transportation

Apart from the railway-lake vessel connection to Appalachia, the only other major means of coal transportation to Ontario is Ontario Hydro's system of unit trains from the West to the new Thunder Bay terminal and trans-shipment to self-unloading lake vessels, whose size is limited by the Sault Ste. Marie and Welland Canal locks.

With greater market penetration by Nova Scotian coal, the St. Lawrence Seaway could become a third important route. But future development will likely consist of refinements to these systems; no technological innovations in transport, such as slurry pipelines, seem worth pursuing at present in Ontario.

Technology

Research and development is taking place in several areas of particular relevance to Ontario. Processes of sulphur removal and coal-cleaning at source and of drying and pelletizing lignite are being investigated. Fluid bed combustion techniques, which give very efficient combustion and reduced stack emissions, are practical on a smaller industrial scale. But units large enough for the needs of Ontario Hydro are some years away.

Coal conversion to synthetic liquid fuels is becoming commercially feasible, though as yet thermal efficiencies exceed 50 per cent only in experimental projects. Liquefaction facilities are most economical on a very large scale at the mine site; such a mine/plant combination would take seven to ten years to reach commercial production. Gasification techniques are more expensive than liquefaction methods. Other research is primarily aimed at enabling cheaper, more abundant, lower-grade types of coal to be used for coke-making, to reduce reliance on high-grade metallurgical coal in steel mills.

Introduction

After decades of declining consumption, coal has begun to return to public attention in the wake of the 1973 OPEC oil embargo, subsequent oil price increases and threats of shortages. In Canada, as in the United States and other countries, there have been expectations of a rebirth of the coal industry to meet the substantial predicted increases in demand. For example, in the 1976 Energy, Mines and Resources Canada report entitled *An Energy Strategy for Canada,* coal demands were expected to increase from approximately 27 million tonnes in 1975 to a range of from 56 million to more than 68 million tonnes in 1990, depending on economic conditions and relative energy prices.

Apart from the need to find appropriate oil substitutes, coal's re-emergence on the energy scene reflects the fact that it is the only fossil fuel in abundant supply throughout the world which is not under the specific control of a small group of politically or economically aligned nations.

The World Energy Conference has estimated the ultimately recoverable reserves of coal to be in excess of 10,000 billion tonnes. On a more realistic scale, recoverable reserves costing less than $25 a tonne ($ 1976 U.S.) are estimated at more than 600 billion tonnes. At present rates of production, the economically recoverable reserves would last more than 200 years and the ultimately recoverable reserves would have a life expectancy of more than 3,700 years.

Although 46 per cent of the estimated economically recoverable coal reserves are in communist countries, 32 per cent of the reserves are located in North America. North American production now accounts for about one-quarter of world production.

Proven and economically recoverable coal reserves in Canada exceed 25 billion tonnes — more than 12 per cent of the North American total. Ultimately, recoverable Canadian reserves may exceed 200 billion tonnes. At the 1979 production level of 33 million tonnes — the energy equivalent of more than 19.24 million cubic metres* (121 million barrels) of crude oil — Canada's economically recoverable proven reserves would last for hundreds of years. Increased production could change this estimate dramatically, but the nation's coal reserves clearly represent a vast energy potential, and coal will play a central role in Canada's strategic energy planning.

In 1979, Canada exported 13.6 million of its 33 million tonnes production. However, imports in that year amounted to 17.4 million tonnes, making Canada a net importer. The generation of electricity accounted for more than 72 per cent of 1979 Canadian coal consumption, with the steel industry consuming an additional 23 per cent and the balance going to other industrial users.

At present Ontario does not produce any coal. But, with 1979 consumption of 17.6 million tonnes — more than 51 per cent of total Canadian consumption — Ontario is the largest coal market in the country. Moreover, Ontario accounted for almost all Canadian coal imports in 1979. From the provincial perspective, coal is an important element in the energy mix; from the national perspective, Ontario is an important element in the overall pattern of coal production and consumption.

This report does not attempt to address environmental matters relating to the use of coal. Readers wishing to pursue this aspect are advised to contact the Ontario Ministry of the Environment.

By taking an Ontario perspective, the report develops further the analysis of coal supply and consumption presented in the *Ontario Energy Review,* published in June 1979.

Readers interested in forecasts will find in the *Ontario Energy Review* projections of three possible energy futures corresponding to various assumptions about the future prices and availability of different energy forms, including coal. The *Review* also provides the broad energy background for this report.

* Cubic metre: 0.15899 cubic metres = 1 barrel

Ontario Coal Consumption

In 1979, coal accounted for about 15 per cent of total primary energy consumption in Ontario. Coal's 1979 share of end-use, or secondary, energy consumption was approximately eight per cent. Ontario's coal consumption in 1979 was about 17.6 million tonnes.

Figure 1 shows the level of coal consumption in Ontario since 1965, by major user category and Figure 2 shows the change in market share of end-use energy types in Ontario. Consumption grew from 1965 to a 1979 level of 17.6 million tonnes, largely because of the increasing use of thermal coal for electrical generation by Ontario Hydro. The use of thermal coal to generate electricity has almost doubled since 1965. This represents an increase of total coal consumption from about 29 per cent to 56 per cent of total provincial coal consumption in 1979.

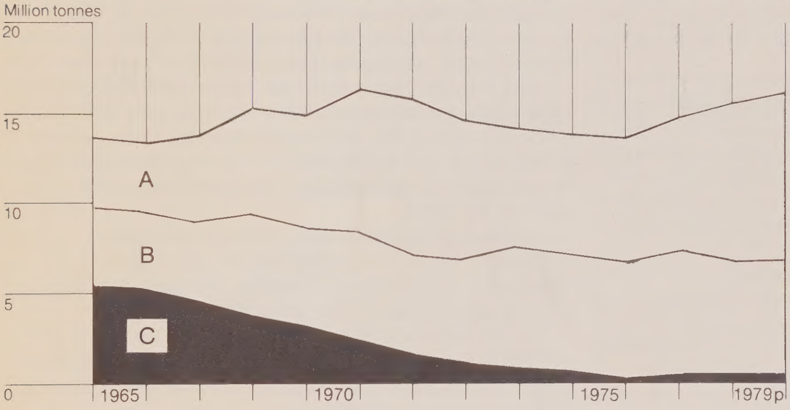
addition of a small amount of oil and gas-fired capacity and some electricity purchases to make up the difference between the base load and the peaks in demand.

Coal-fired stations also provide a contingency backup to the total system and are used to generate electricity for export. The contributions of different fuels to the Ontario Hydro generating system in 1979 are compared in Figure 3.

In 1979, Ontario Hydro used 9.9 million tonnes of coal, up from 9.1 million tonnes the previous year. Its coal requirement is part of a broad fuel supply program, which in turn is based on its system-wide operations and expansion programs. These programs are based on Ontario Hydro's load forecast, taking into account load management targets plus requirements for reserve capacity to ensure reliable performance.

FIGURE 1

COAL CONSUMPTION IN ONTARIO



A - Thermal generation of electricity
B - Metallurgical use
C - Residential, Commercial, Industrial, and Transportation sales

	'000 tonnes
1975	13,636.0
1976	14,904.0
1977	15,580.3
1978	15,989.1
1979	17,629.6

p-Preliminary
Source: Statistics Canada Publications 45-002, 26-206.

The use of metallurgical coal to produce coke for steel manufacturing has also increased. This accounted for about 41 per cent of total provincial coal consumption in 1979, compared to 32 per cent in 1965.

Thermal coal consumption for space and process heating in the industrial, commercial, and residential sectors has declined markedly. From a 1965 level of 39 per cent, those sectors in 1979 accounted for only about three per cent of provincial coal consumption.

Coal consumption in transportation was virtually eliminated before 1965 when railroads switched to diesel fuel.

The following is a close look at each type of coal consumption in Ontario.

Ontario Hydro

In the Ontario Hydro system, large hydraulic and nuclear generating stations provide base-load capacity. Coal-fired stations are primarily used in conjunction with small hydraulic stations with the

FIGURE 2

Change in Market Share of End-Use Energy Types in Ontario

Energy Type	Market Share (%) 1960	1970	1979E
Coal and Coke*	29.0	14.0	8.7
Crude Oil	50.0	49.0	45.3
Natural Gas	10.0	24.0	29.6
Electricity**	11.0	13.0	15.6

* Includes coke oven gas
**Includes purchases
E-Estimate
Source: Statistics Canada Publication 57-003.

FIGURE 3

A summary of Ontario Hydro's generation system for 1979

	Capacity		Energy*	
Type of generation	Million kW	% Total	Billions of kWh	% Total
Hydraulic	6.5	27.7	38.8	38.1
Fossil thermal				
Oil	2.1	8.9	0.9	0.9
Natural Gas	0.9	3.8	1.5	1.4
Coal	9.0	38.3	28.5	27.9
Total	12.0	51.0	30.9	30.2
Nuclear thermal	5.0	21.3	33.3	31.7
Total	23.5	100.0	103.0	100.0

*In 1979, purchases from Quebec and Manitoba (mainly hydraulic) were 8.602 billion kWh and exports (mainly coal) to the U.S. were 12.5 billion kWh.

Source: Ontario Hydro.

Important issues in Ontario Hydro's fuel supply include cost, quality, security and flexibility of supply, and environmental considerations. The decision process is a dynamic one, with the absolute amounts of specific fuels and the mix of fuels determined by such developments and contingencies as:

—year-to-year and long-term deviations between the actual and forecast load demands;
—changes in system generation expansion programs;
—reductions in generation due to station outages;
—variability in hydraulic resources;
—variability in purchases and export sales of electricity;
—power transmission limitations;
—variations in station performance; and
—fuel availability and logistics problems.

The uncertainties make it essential that fuel supply be flexible so that the quantities delivered can be matched to changing needs. Flexibility is achieved by stockpiling, by contracts allowing increases or decreases in deliveries, by purchases on the spot market, by a mix of fuel supply contracts with different termination dates, by sales of surplus fuel, and by fuel substitution through selective station operation.

Ontario Hydro's long-term coal requirements forecast for primary electricity demand have been dropping. At the end of 1975, the projected requirement for 1985 was 17.5 million U.S. equivalent tonnes (on a kJ (BTU) basis); by 1978 the projected 1985 requirement had fallen to 11.0 million tonnes. Similar reductions were made in the estimates for the year 1990 and 1995 — from 19.7 million to 11.5 million tonnes and from 26.1 million to 13.6 million tonnes. Current projections show further declines for 1985 and 1990 to nine and approximately eight million tonnes respectively.

These revisions indicated the decline in the long-term load forecast, which in turn reflected changed projections of economic conditions and the effects of conservation programs and price increases. In addition, the performance of Ontario Hydro's nuclear plants was exceeding expectations.

Projections over the same time period (1985-1990) indicate that secondary or export sales could add between 1.8 and 4.5 million tonnes per year to the coal requirements.

In the short term, fluctuations in electricity exports and imports are the major uncertainty in demand projections for coal.

Future coal needs will be affected also by the changing composition of the Ontario Hydro generating system. As new stations have come on stream in the past, older stations have been kept in service to provide reserve capacity. But as the system expands in the future, the principal reserve capacity will be the existing coal-fired stations.

At present, no large new coal-fired stations have been committed, and a total of only 700 MW of coal capacity is under construction. In contrast, a total of about 8,500 MW of new nuclear capacity is under construction and scheduled to come into service by 1991.

Ontario Hydro's coal requirements will, therefore, be increasingly influenced not only by the actual utilization of reserve capacity but also by the amount and type of it that exists.

Coal-fired stations are generally used to serve intermediate and peak loads and placed in reserve. Therefore, overall coal consumption is expected to remain fairly constant.

Coal stacker at Nanticoke Generating Station

FIGURE 4

Canadian and U.S. bituminous coal characteristics

Bituminous coal qualities	U.S. Origin	Western Canadian
Ash (%)	8	10.5 - 18.5
Moisture (%)	6	1 - 8
Volatile matter (%)	35	21.3 - 34.7
Hardgrove grindability	55	84 - 94
Sulphur (%)	2.25	0.3 - 0.5
Calorific value (kJ/kg)	30,238	25,586 - 27,958

Source: Prepared for Ontario Ministry of Energy by Dames and Moore, March 1979.

Ontario Hydro uses bituminous coal from the United States and Western Canada and will in future be using some Western Canadian lignite. The U.S. and Western Canadian bituminous coals have different characteristics, as shown in Figure 4. In addition to those differences, Western Canadian coal is more friable, does not readily flow in bins, and forms a fundamentally different kind of ash (lignitic).

FIGURE 5

Ontario Hydro: coal-fired generation stations

Name	Location	Units	Nameplate rating per unit (MW)	Total nameplate rating, all units (MW)
Stations designed to operate on American coal				
J.C. Keith	Windsor	4	66	264
Thunder Bay	Thunder Bay	1	100	100
R.L. Hearn	Toronto	4	200*	800
Lakeview	Mississauga	8	300	2,400
Lambton	Sarnia	4	500	2,000
Subtotal nameplate ratings				5,564
Stations designed to operate on Canadian bituminous coal and lignite				
Thunder Bay (L)	Thunder Bay	2	150	300
Atikokan (L)	Atikokan	2	200	400
Subtotal nameplate ratings				700
Stations designed to operate on a blend of U.S./Canadian coal				
Nanticoke	Nanticoke	8	500**	4,000
Total				10,264

Note: The Thunder Bay lignite-fuelled extension and Atikokan, are under construction. Some Nanticoke units are under repair. J.C. Keith is being renovated and will not be brought into service until its capacity is required.

* these units have dual fuel capability (gas/coal).

** Nanticoke (8 x 500 MW units) is set up for 50/50 blend US/Canadian bituminous coal.

L-lignite

Source: Ontario Hydro

These differences mean that Ontario Hydro cannot always switch easily from one type of coal to another. Conventional large fossil-fuelled boilers for electricity generation are designed for the specific characteristics of the coal to be used. Deviation from the design fuel can result in derating of the boiler and increased generating costs unless major modifications are undertaken.

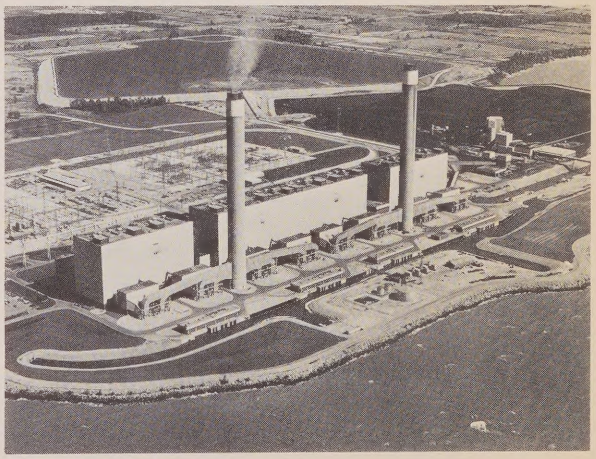
Burning Western Canadian coal in a boiler designed for U.S. bituminous coal could lead to lower net thermal efficiency, reduced power output, combustion and safety problems, ash removal problems, increased requirements for boiler maintenance, and the release of more fly ash into the atmosphere.[1]

Figure 5 indicates the location and size of the coal-fired generating stations in the Ontario Hydro system and their compatibility with U.S. and Canadian coals. Nanticoke is the only generating station able to blend coal. The Thunder Bay extension has been designed for a wide range of Canadian coals (from lignite to bituminous) but at the expense of a loss in net thermal efficiency.

The Steel Industry

The three Ontario steel companies — Algoma, Stelco, and Dofasco — employ coke ovens and blast furnaces to make iron, the fundamental ingredient of steel. In a typical integrated steel plant using these processes, approximately 74 per cent of the energy consumed is in the form of metallurgical coal used for the production of coke. Good quality coke requires a coal blend that contains 20 to 25 per cent low-volatile coal.

Figure 6 shows 1979 raw steel production and coal use by the three Ontario steel-makers and the amount of metallurgical coal used as a percentage of the raw steel output.



Aerial view of Nanticoke Generating Station - Sept/79

[1] Coal from the Canadian Maritime provinces, however, is comparable to U.S. bituminous coal and can readily be substituted in stations designed for U.S. coal.

FIGURE 6

1979 raw steel production and coal use by Ontario steel-makers (000 tonnes)

	Total
Raw steel production	12,199
Total coking coal	7,319
Coking coal as a percentage of raw steel production (weight)	60

Source: Ontario Steel Producers.

Within the limitations imposed by technical and economic factors, there has been a continuing effort to reduce the coke rate in blast furnaces, to reduce the total consumption of coking coals, and to adopt lower-cost and more readily available coals for coking purposes. The production of coke for the blast furnace is the highest single conversion-cost item in steel-making. Optimizing the amount of coke required per tonne of hot metal has therefore been the subject of intensive investigation.

Over the past 20 years, coke rates have been reduced by about 45 per cent to current averages of about 500 kilograms per tonne of liquid iron or about 0.63 tonnes of metallurgical coal per tonne of raw steel production.

It may become technologically possible to reduce this ratio further to as low as 0.3 over the next several decades, but the realistic attainable minimum is more likely to be about 0.44. An important factor will be the price of the fuels used in place of coke. A variety of substitutes for coke are now used, including oil and natural gas, as well as oxygen enrichment techniques and close quality control of iron ore pellet specifications.

'Other' Sectors

In 1974, users other than Ontario Hydro and the steel-makers, accounted for seven per cent of coal consumed in Ontario. Virtually all of this amount (98 per cent) was consumed by 21 separate companies in 10 different industry groups operating 27 plants in the province.

By 1977, approximately 81 per cent of the 629,400 tonnes of coal used by the 'other' industrial users in Ontario was consumed by the pulp and paper and the cement industries and a further 14 per cent by the smelting and refining and the motor vehicle manufacturing industries. In that year, the remaining five per cent was consumed by an additional 25 users.

Figure 7 shows historic coal consumption for each of the 10 industrial groups accounting for the bulk of industrial coal use in the province. Pulp and paper plants are located in the northern portion of the province where heavy fuel oil does not have a competitive advantage. Most cement plants are located at or near lakefront docks, reducing the transportation component of total coal costs. The operations of both industries are particularly suited to coal use.

In 1960, coal supplied 12.2 per cent of the residential fuel market in Ontario. That proportion declined to 0.1 per cent in 1974 and has not even been recorded since then. Residential coal use is now virtually limited to regions beyond the economic market of fuel oil and natural gas. Coal's major competitor in this peripheral market is wood.

A similar situation has prevailed in the commercial and small industrial coal markets. In 1960, coal provided 28.6 per cent of the total energy consumed in the commercial market. By 1974, coal's contribution had declined to 1.2 per cent and since then has not been sufficient to be recorded.

Coal generally is not price-competitive with alternative fuels in the residential, commercial, and small industrial markets. To be competitive with natural gas, coal must be delivered at a kJ(BTU)cost estimated at no more than 70 to 80 per cent of the cost of natural gas at the burner tip. For the small industrial user — consuming less than 1800 tonnes a year in 1979 — the cost of delivered coal varied from \$2.75/GJ* to \$3.45/GJ, compared to natural gas at about \$2.90/GJ at the Toronto burner tip. For the residential or commercial user, the coal cost would be even higher due to higher handling and delivery charges.

FIGURE 7

Coal consumption by 'other' industrial users in Ontario, 1965-77 (000 tonnes)

	1965	1974	1975	1977
Pulp & paper mills	833	454	200	191
Cement manufacturers	515	174	134	316
Smelting & refining	492	89	55	41
Motor vehicle manufacturers	202	63	44	50
Lime manufacturers	83	26	24	19
Iron foundries	27	16	5	0.4
Motor vehicle parts & accessories	146	9	2	0
Manufacturers of industrial chemicals	1062	9	1	2
Paper box & bag manufacturers	15	2	2	0
Fruit & vegetable processing industries	21	1	2	1
Other	909	16	10	9
Total	4305	859	479	629.4

Source: Consumption of Fuel and Electricity by Ontario Manufacturing Industries, Central Statistical Services, Ontario Ministry of Treasury and Economics.

*Gigajoule: 1.055 gigajoules = 1 x 10^6 British thermal units (BTU).


Pushing coke from one of Stelco's 191 coke ovens

Coal must be priced lower than competitive fuels because of such problems as its relative uncleanliness, its difficulty of handling and the land use costs it entails. Further, coal's competitive position has been hurt by the virtual disappearance of a handling and marketing infrastructure to meet the needs of smaller users. When coal was still a major energy source in Ontario, 300 dealers serviced the Metropolitan Toronto residential market. That number is now reduced to five. The result is higher unit costs, longer delivery hauls, reduced competition, and increased delivered costs to small consumers.

Ontario Coal Supply

Ontario produces no coal and must rely on sources outside the province. Figure 8 shows that about 87 per cent of Ontario's 1979 coal supplies came from the United States and the remaining 13 per cent from Western Canada and the Maritimes.

United States Sources

Ontario is now the largest export market for U.S. coal. Whereas most other U.S. coal importers buy only the higher-quality metallurgical grades, both steam and metallurgical coals are sold to Ontario. This large, long-established coal trade is important to both countries, representing significant U.S. employment, large Canadian investments in the U.S. industry, and a competitive and reliable energy source for Ontario.

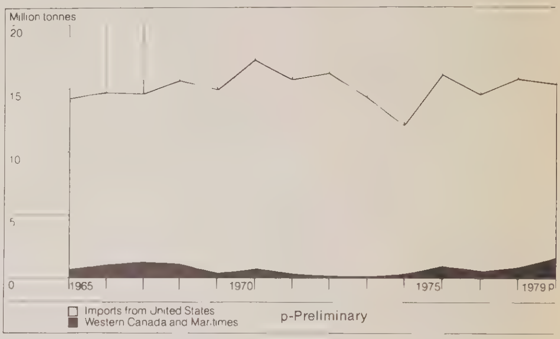
The U.S. coal comes from the Appalachian states of Kentucky, Pennsylvania, Virginia, and West Virginia (Figure 9).

The Appalachian area is the largest coal-producing region in the United States, accounting for approximately 50 per cent of U.S. output in 1979. The region has a variety of coal users and suppliers and many different coal types, including substantial reserves of relatively high quality bituminous coal. Ontario purchasers do not dominate the coal industry in any Appalachian county.

In general, the eastern U.S. coal market is mature and competitive and responds rapidly to short-term swings in demand. A growing proportion of transactions, however, include long-term contracts with cost-adjustment clauses. In addition, smaller marginal producers will become less important in the future as they find it increasingly difficult to cope with government health, safety, planning, and reclamation standards.

FIGURE 8

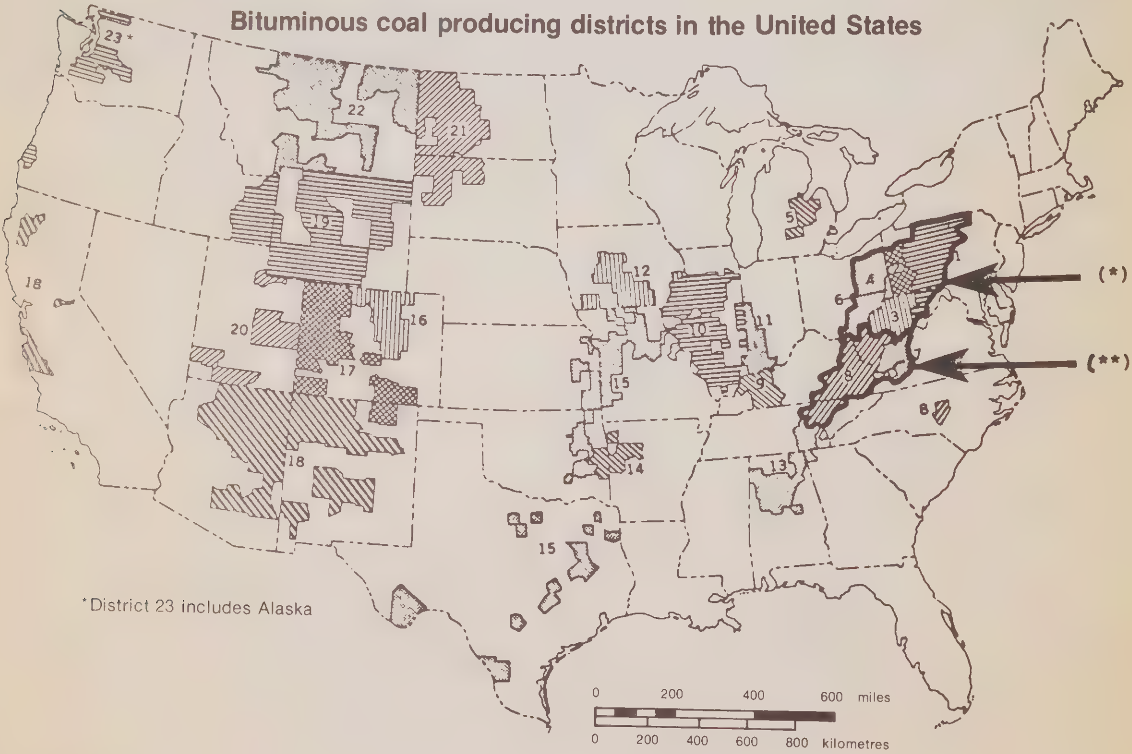
Ontario coal supplies 1965-79



Sources: Statistics Canada Publications 28-206, 45-002.

FIGURE 9

Bituminous coal producing districts in the United States



*District 23 includes Alaska

* Source of medium-sulphur steam coal for Ontario Hydro.

**Source of high-volatile and low-volatile metallurgical coal.

Permanent loss of the small producers may reduce the industry's ability to accommodate short-term changes in demand. On the other hand, the current preference for long-term contracts or dedicated mines on the part of utilities, which dominate the eastern market, will tend to impose medium-term and long-term discipline on coal prices, a tendency enhanced by federal regulations requiring the publishing of market data.

In general, Appalachian coal prices are closely related to mining and transportation costs, and only in the spot market in periods of high demand do prices diverge significantly from costs.

The American coal mining industry is evolving in response to changes in demand and the emergence of competitive producing regions in the west. The industry now undertakes longer-range planning and releases more information to the public; mines are getting larger and more of them are dedicated to a single customer; production is concentrating into fewer firms; greater attention is being devoted to product quality and matching it to consumer specifications; mechanization is becoming more intensive; and management is being improved.

Demonstrated reserves of low-sulphur and medium-sulphur bituminous coal in those counties now supplying Ontario consumers are in the order of 3.8 billion tonnes *in situ*. However, some regional reserve estimates have been severely criticized, and there is some concern that depletion of accessible coal in Appalachia may inhibit the growth of the domestic U.S. coal market. The U.S. steel industry in particular has sought to impress on government a concern for the long-term availability of metallurgical coal, especially the low-volatile grades. The following facts have been emphasized in the recent past:

— only 13 per cent of the premium and marginal coal resources in the United States are of low-volatile grade, and in 1974 from 40 to 45 per cent of the total of this grade mined was exported;
— although domestic consumption declined 5 per cent in 1975, exports increased by 10 per cent;
— of 60 million tonnes of bituminous coal exported in 1975, 52 million tonnes went to Japan, the European Economic Community, and Canada, with Canada second only to Japan, taking 25 per cent of the total exported
— 37 per cent of bituminous coal production was burned as steam coal by utilities and industrial plants attempting to comply with environmental standards on sulphur emissions, thereby putting additional pressure on available supplies.

Although these statistics have changed slightly over the past three years, the basic elements have not altered significantly, except that the decline of Japanese purchases has made Ontario the leading U.S. coal export market. Accordingly, the American Iron Steel Institute recommended that the U.S. government monitor the export of low-volatile coals. In 1978, this recommendation was partly implemented, and steam and metallurgical coal exports are now separately monitored.

Since the early 1970s, Ontario Hydro and the Ontario steel industry have been diversifying in order to avoid an almost total reliance on U.S. coals by using Western Canadian and Nova Scotian sources. The chief reasons for the diversification programs were as follows:

— the perception in the United States that reserves of low-volatile bituminous coking coal were rapidly depleting in Appalachia and that worldwide resources were relatively small;
— the requests made in 1974 by the American steel industry for export limits to be set on low-volatile bituminous coal;
— a belief that Appalachian mining costs would rise more rapidly than elsewhere as a result of health and safety legislation, environmental control requirements, and fundamental changes in the mining labour force;
— pressure by U.S. consumers (i.e. utilities) to obtain compliance low-sulphur coal to meet more stringent SO_2 emission standards; a pressure sufficiently intense for metallurgical coals to find their way into the steam coal market.

These concerns were reinforced by President Carter's energy plan and his goal of cutting reliance on imported oil by increasing the use of coal; an expansion of coal production to 1.1 billion tonnes in 1985 was proposed. If American coal demand was to expand as rapidly as hoped, it was only prudent for Ontario consumers to decrease their dependence on American sources.

Since the early 1970s, circumstances have significantly altered the American coal situation:

— reserves of low-volatile bituminous metallurgical coal are not so limited (at least not in the view of the U.S. government);
— worldwide, the steel industry is sluggish, and the Japanese in particular, have reduced their reliance on American coal (particularly low-volatile grades);
— mining costs have increased and productivity in Appalachia has deteriorated as anticipated, but prices have not risen in proportion and manpower availability is no longer thought to be a constraint on industry expansion;
— competition for compliance coal has declined as electrical demand growth has slowed and as the atmospheric emission legislation has stalled in the courts;
— now that SO_2 scrubbers in some form will probably become compulsory, there is reduced competition for new long-term supplies of low-sulphur coal;
— President Carter's energy plan has been much delayed and changed in Congress, effectively postponing coal expansion.

The past two to three years have been a buyer's market for U.S. coal, and the immediate and medium-term pressures for Ontario consumers to change their buying strategies have declined. This situation should not be affected by current U.S. government initiatives to convert 80

Western Canadian coal minehead

northeastern U.S. power plants from oil to coal, given the June 1980 Venice economic summit, at which Canada and the U.S. endorsed a commitment to double coal production by 1990.

The existence of the U.S. spot market has proved to be an advantage to Ontario consumers. Apart from showing the availability of surplus production or increasing demand, the spot market allows consumers to experiment with new coal sources, to balance long-term supplies and short-term demand while avoiding high inventory costs, and to take advantage of occasional low prices.

Unfortunately, the future of the U.S. spot market is uncertain. Very likely it will either decline or change greatly as a result of the withdrawal of small operators, depressed demand conditions, the preferences of utilities for long-term contracts or dedicated production, and the rapid development of Western U.S. coal and its penetration into traditional Appalachian markets.

Canadian Sources

Western Canadian coal producers and developers view Ontario as a difficult market to penetrate because of its economic and technical ties with U.S. producers and because of the costs of transportation. Although Western Canadian minehead prices are competitive with American prices, Western Canadian coal landed in Ontario is significantly more expensive than Appalachian coal, primarily because of transportation costs.

Western Canadian producers look to Southeast Asia, South America, and Europe as the principal markets for high-grade thermal and metallurgical coals and to local Alberta, British Columbia, and Saskatchewan power generation requirements for lower-quality coal.

Western Canadian mines are able to supply Ontario with substantially more coal than they now do. But market penetration in Ontario by Western Canadian coal is limited by market size and a substantial price differential with U.S. coal. Canadian mines are typically developed on long-term contracts; as there are few small Canadian producers and there is no Canadian spot market, there must be an assured long-term demand of sufficient size to justify the development of a new mine.

Apart from Ontario Hydro and the steel-makers, individual Ontario buyers are generally too small to command the priority given to major consumers and exports. The small size of these other Ontario sales prevent any transportation economies of scale that would reduce landed costs to Ontario consumers; for instance, about 450,000 tonnes a year are required for a unit-train service.

Different circumstances prevail with Nova Scotia supplies. Nova Scotian thermal coal is sufficiently similar to American coal that it can readily be substituted in Ontario Hydro facilities. Furthermore, the transportation distances and modes could enable Nova Scotian coal to be landed in Ontario at competitive prices, subject to its availability. The same applies to Nova Scotian high-volatile metallurgical coal, although Ontario steel-makers cite some concerns with quality control and with Maritime shipping facilities.

In the past, the penetration of the Ontario market by Nova Scotian coal has been limited primarily by inadequate supplies of coal of consistent and acceptable quality. This constraint does not reflect Nova Scotia's total resource base but rather the limited development of its proven reserves. It also reflects the production limitations of operating mines compared to Nova Scotia's own market demands and its other long-term contractual commitments. Development of new large mines may change this situation, and Nova Scotia could meet a part of Ontario's coal requirements.

Ontario Hydro Supplies

Ontario Hydro now has contracts for approximately 12 million tonnes of coal a year from a variety of American suppliers with termination dates ranging from 1979-80 to 2007. These contracts are relatively flexible, permitting downward revisions of about 1.2 million tonnes a year and upward revisions of about 0.8 million tonnes a year. Because of the longstanding relationships between Ontario Hydro and its suppliers, additional downward flexibility of up to 0.45 million tonnes a year could probably be obtained in extreme circumstances without price penalties. In addition, arrangements on the largest contract allow Hydro to sell surplus coal. The spot market provides additional upward flexibility. In 1979, actual deliveries from the U.S. amounted to 10.7 million tonnes.

As part of its energy-source diversification program, Ontario Hydro signed long-term contracts (to 1993) for 2.5 million tonnes a year of bituminous coal from two new mines in Western Canada. Contracts were also signed for about one million tonnes a year of lignite from Saskatchewan as fuel for the Thunder Bay extension.

To help move this coal as efficiently and inexpensively as possible, Ontario Hydro purchased eight unit-train sets and supported the development of a coal transfer and storage terminal at Thunder Bay. The terminal has an ultimate capacity of six million tonnes a year, with current throughputs reaching 2.5 million tonnes a year, which will increase to 3.5 million tonnes when the lignite deliveries begin in 1981.

These Canadian supply arrangements are less flexible than those with American suppliers, partially because much of the Canadian supply originates in dedicated mines and also because of the large investments needed in new facilities and infrastructure. The bituminous coal quantities from Canadian suppliers are purchased under contracts for essentially fixed total amounts but permitting deviations in annual purchases of about +8 and -6

per cent. Annual lignite volumes will be allowed to vary by about ±10 per cent. The infrastructure investments represent a long-term commitment to a specific means of delivery.

FIGURE 10

Coking coal supplies into Ontario, 1979 (000 tonnes)

Steel-maker	Eastern United States	Canadian Sources	Total	Percentage Canadian
Total	6,871	448	7,319	6.1

Source: Ontario Steel Producers.

Steel Industry Supplies

Figure 10 shows the sources of supply of metallurgical coal for the three Ontario steel companies in 1979. The results of the steel industry's diversification program are evident in the 6.1 per cent of supplies drawn from Canadian sources. The steel manufacturers have a much higher security of supply for critical low-volatile coals than for high-volatile coals. For example, Dofasco's only equity participation in a coal mine is with a U.S. supplier of a portion of their low-volatile coal requirements. The majority of Stelco's low-volatile coal comes from mines in West Virginia in which it has an equity participation. Algoma continues to supply all its coal requirements from dedicated American mines.

Further reliance by steel-makers on Canadian sources of coking coal has not occurred, partly because Canadian mines in Western Canada were occupied with building Japanese trade in the early 1970s, when coal requirements were growing in Ontario. At that time, moreover, British Columbia and Alberta did not encourage new mines beyond those required for the overseas trade.

Although the steel industry has moved to reduce its dependence on American sources, as shown by Figure 10, a rapid increase in supplies from Canadian sources would be expensive and difficult to accomplish. With Western Canadian coal the chief difficulty is transportation. With Nova Scotian coal the problem is the availability of sufficient quantities of coal of acceptable and consistent quality. Furthermore, Western Canadian coals have different physical and chemical characteristics from U.S. coals and would require sophisticated and costly blending procedures.

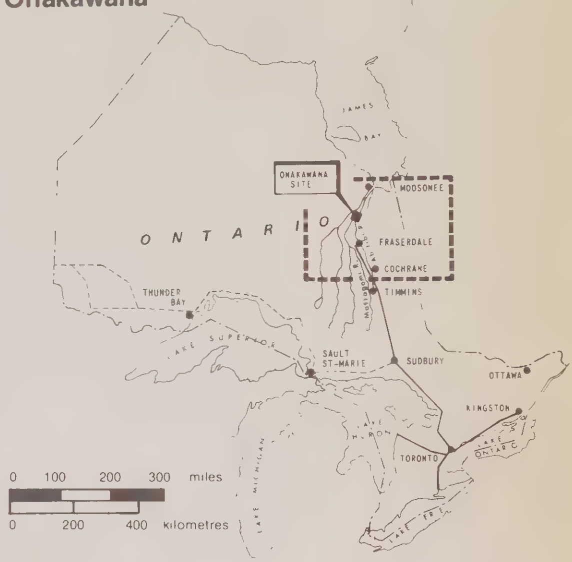
Supplies For 'Other' Users

Apart from some Saskatchewan lignite used by the pulp and paper industry along with U.S. bituminous coal, coal from Canadian sources is not used by other consumers in Ontario. The balance of the 'other' market relies entirely on U.S. coal.

Larger Ontario consumers buy coal direct from the mining company, from wholesalers or brokers in the United States, or from one of the two major industrial coal wholesalers operating in Toronto. Small consumers are more likely to purchase coal from one of the Toronto wholesalers.

FIGURE 11

Onakawana



Onakawana Lignite

The Onakawana lignite deposit in the James Bay lowlands, shown in Figure 11, is Ontario's only known coal deposit. To date, approximately 190 million mineable tonnes of low-grade lignite (averaging about 11,530 kJ/kg or 5,000 BTU/lb) have been delineated. This is a substantial resource, equivalent to about 80 million tonnes of Western Canadian bituminous coal, and there is a possibility of further discoveries.

The subject of various studies over the years, Onakawana is now being examined by Ontario Hydro and Onakawana Development Ltd. (a wholly-owned subsidiary of Manalta Coal Ltd.). The study will examine the feasibility of establishing a 1,000 MW mine-mouth electrical generating station to utilize the lignite deposit.

With an operating life of at least 30 years, the proposed generating station would require an average of 4.3 million tonnes of lignite annually.

The research, which will be finalized in mid-1981, will enable completion of all preliminary steps from consideration of Northern Ontario's

Excavation at Onakawana site

power needs to environmental assessment prior to making a decision to proceed to final approvals for construction of a mine-mouth generating station.

To find more indigenous coal, the Ontario government is encouraging private companies to undertake mineral exploration programs in the James Bay lowlands, either alone or in joint ventures with the Ontario Energy Corporation.

Currently, four private companies have applied for licences to explore for lignite and other minerals. The Ontario Energy Corporation has also been granted a licence to explore for lignite and will be undertaking a program in the fall of 1980.

Transportation

Most coal supplies reach Ontario consumers over one of two major transportation systems:
—from Appalachia via rail and lake vessel (Figure 13);
—from Western Canada via unit train, the Thunder Bay terminal, and lake vessel (Figure 12).

The remaining volumes are moved in one of three additional systems that have been adopted to meet particular requirements:
— from Western Canada via rail and ocean freighter through the Panama Canal and the St. Lawrence Seaway;
— from Nova Scotia via ship through the St. Lawrence Seaway;
— from Appalachia via an all-rail route.

The St. Lawrence Seaway route from Nova Scotia could become more important in future if increased volumes of Nova Scotian coal penetrate Ontario markets, but the two major systems (Appalachia Rail and Vessel, and Western Canada System) now represent the most important and economical ways to move large volumes of coal to Ontario.

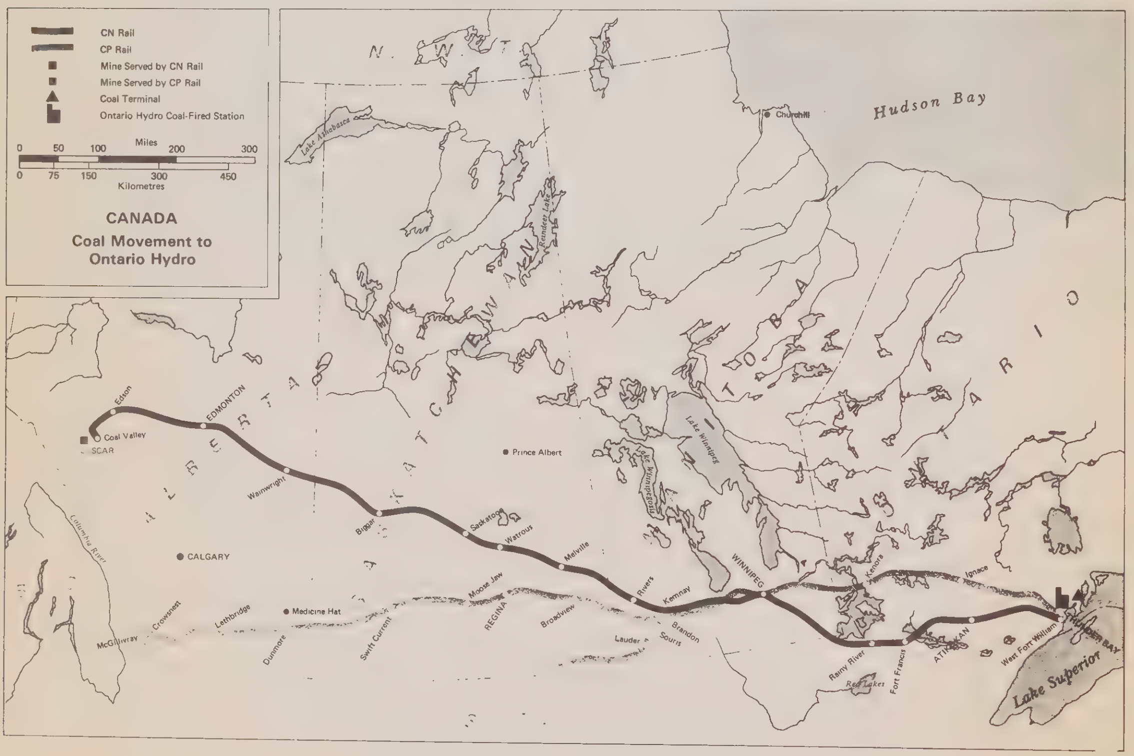
Because coal is a bulk commodity and relatively difficult to handle, the cost of transporting it from mine to market can account for a large proportion of the price paid by the consumer. The distance to Southern Ontario from Western Canadian coal fields ranges from 2,400 to 3,800 km, compared to a typical haul of 700 km from Appalachian mines. The longer distances associated with Western Canadian coal give it a transportation cost component in Ontario significantly higher than that of Appalachian coal. This disadvantage is magnified by the fact that Western Canadian coal has a lower kJ (BTU) value per unit; the transportation cost per unit of energy value is thus even higher than that implied by the cost per tonne.

Ontario Hydro estimates that transportation costs for Western Canadian coal account for about 50 per cent of the total landed price per tonne. For Appalachian coal, transportation absorbs only about 14 per cent. In light of the thermal differences between the two types of coal, the transportation component for Western Canadian coal is three to four times greater than for Appalachian coal.

With metallurgical coal, transportation costs represent a slightly smaller proportion of total costs. The prices of metallurgical coals generally are higher per tonne than for steam coals, and F.O.B. (free-on-board) minesite prices therefore have a greater influence on market prices. However, this relationship could be distorted if railways and lake carriers were to adjust their rates to reflect the value of the commodity rather than the true costs of transportation.

Ontario's major coal consumers, situated along the north shores of Lakes Erie

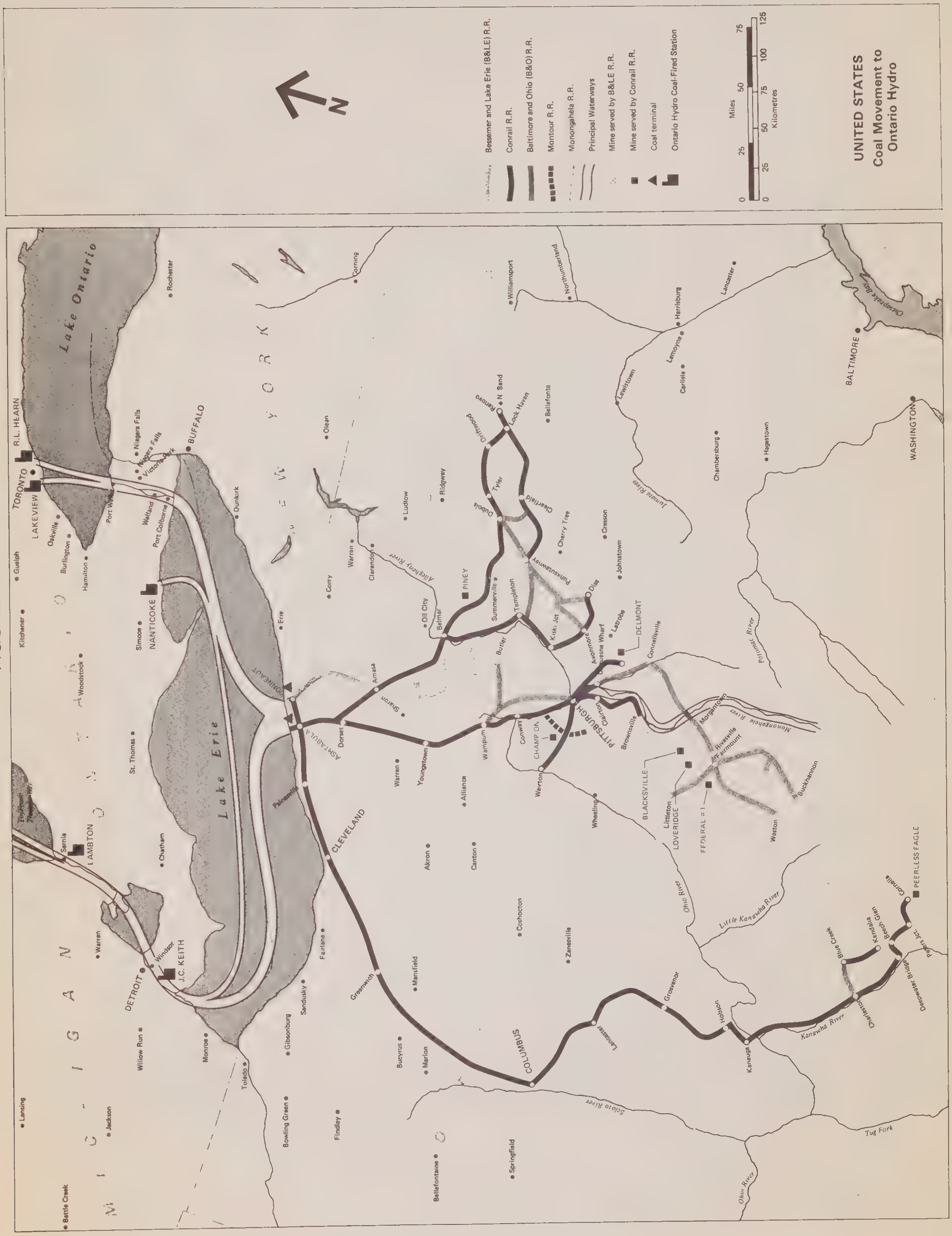
FIGURE 12



and Ontario, are well placed for receiving coal by the most economical mode — lake shipping. To minimize dock facilities, self-unloading lake freighters are used where possible.

For Ontario Hydro and the steel companies, the selection of transportation systems and the logistics of coal movement

FIGURE 13



are constrained by certain site limitations:

- stockpiling and blending space is limited at Hamilton;
- neither steel company at Hamilton or Ontario Hydro can easily receive coal by train;
- Nanticoke is the only generating station with blending facilities.

The transportation systems selected by Ontario Hydro for the movement of Western Canadian coals is the only practical and economical alternative available for the foreseeable future: a slurry pipeline/lake vessel system would require much larger volumes to be economical. The Ontario Hydro system involves rail shipment by dedicated unit trains to Thunder Bay, terminal storage and trans-shipment to self-unloading lake vessels, and passage through the Great Lakes to Nanticoke where the cargo is blended with American coal.

In addition to eight unit trains and the Thunder Bay terminal, Ontario Hydro has contracted for two 28,000-tonne deadweight bulk carriers to handle the initial throughput from Thunder Bay to Nanticoke, operating on a five-day turnaround cycle during the shipping season. Since Nanticoke is above the Welland Canal, larger vessels of up to 50,000 deadweight tonnes could eventually be built and used. However, coal destined for Lake Ontario ports would have to be moved in smaller vessels.

In the medium term, the rail-lake system could be expanded to accommodate growth in the volume of Western Canadian coal moving to Ontario. The issues will probably be concerned with who pays for expansion and the extent to which freight rates are altered. The first physical limitation likely to be encountered is the capacity of the Welland Canal and the Sault Ste. Marie locks.

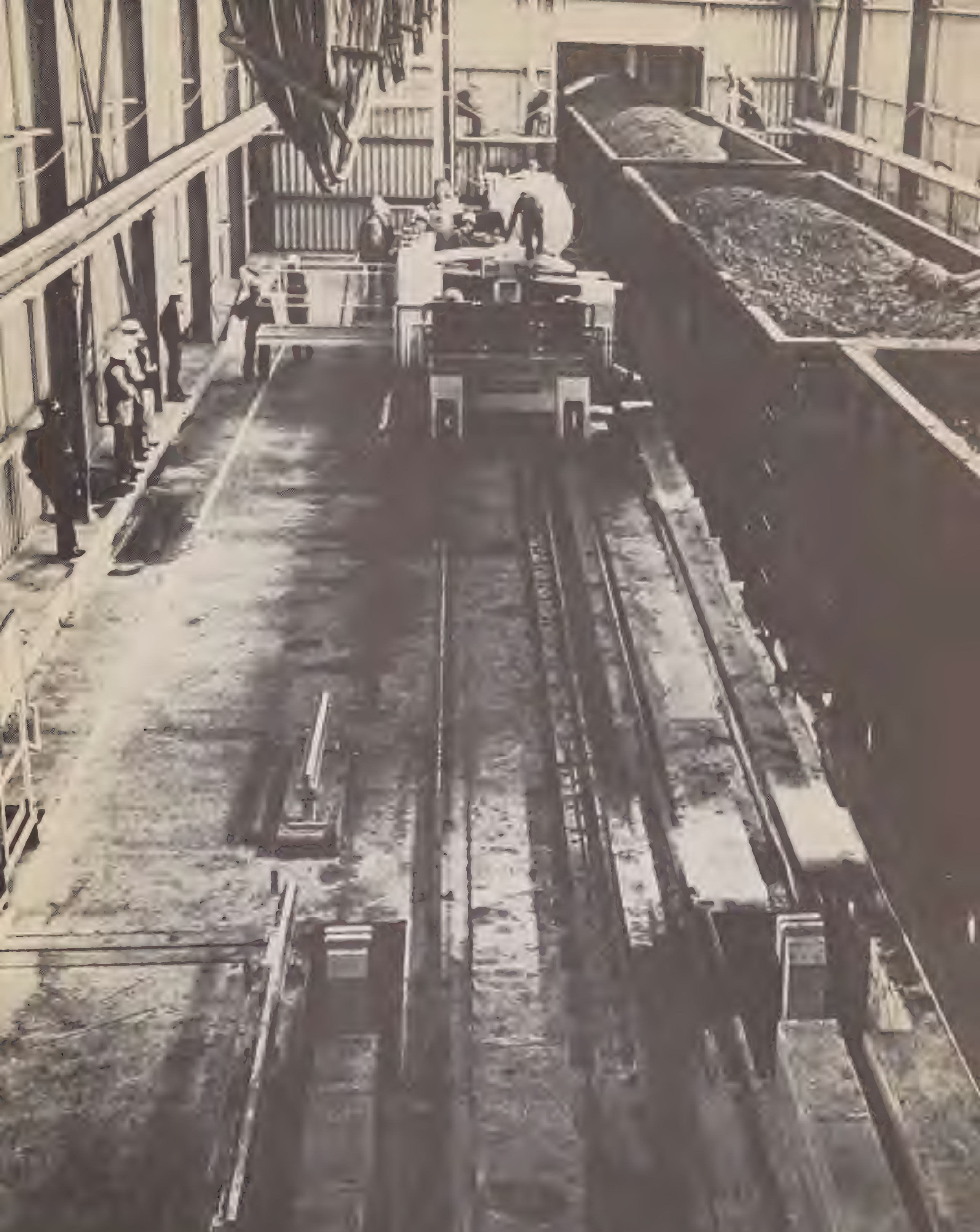
Most coal destined for Ontario and originating in north and central Appalachia, is hauled by rail either in unit trains for Ontario Hydro or minimum 4,500-tonne consignments for the steel industry to the ports of Ashtabula, Sandusky, Toledo, and Conneaut. As Figure 14 shows, all these ports are above the Welland Canal. In addition, about one-quarter of the Ontario-bound coal is barged along the Monongahela River to the Pittsburgh area before trans-shipping for onward movement to Conneaut by railway.

Concern has been expressed about the ability of American railways to handle the massive increases in coal traffic expected to occur under the new U.S. energy policies. The railways are considered the weak link in the U.S. coal supply chain, and any difficulties encountered could harm Ontario consumers. The chief concerns are these:

- the ability of the eastern and midwestern railroads to raise needed capital and manage their affairs;
- unit train movements disrupting rural communities;
- restrictive work rules (union); and
- the impact of federal rules and regulations.

FIGURE 14

Great Lakes and Major Coal Transfer Facilities



A unit train loaded with Western Canadian bituminous coal in the dumper house at Thunder Bay Terminals. The semi-automatic indexer unit, which positions the cars in the rotary dumper, is shown at the upper left.

Coal barge unloading on conveyor belt at
Lakeview Generating Station

Developing Technology

In recent years, coal has become the subject of intensive research and development around the world. The most advanced research and development programs are being undertaken in the European Economic Community, Japan, the United States, and the U.S.S.R. The International Energy Agency provides a mechanism for international co-operation and for the sharing of knowledge and experience.

Compared with those of other countries, Canada's expenditures on coal research and development are small. However, Canada cannot afford to pursue as many research avenues as the United States; Canadian governments and industry must be selective in their research and development projects, while monitoring the work projects being carried out elsewhere.

Figure 15 lists the levels of federal government funding of the various areas of coal research and development now being pursued. The relevance of any given area to Ontario is significantly influenced by:

- a near absence (other than lignite) of indigenous hydrocarbon resources;
- emerging trends in oil and natural gas supply and demand;
- the reliance of Ontario consumers on imported U.S. coal;
- the fact that 97 per cent of provincial coal consumption is by the steel industry and Ontario Hydro;
- the high proportion of total costs accounted for by transportation;
- the difficulty of achieving rapid substitution of coal energy in industries that would in any event be relatively small consumers; and
- existing fixed investments by the steel industry and Ontario Hydro in coal mines, transportation systems, and user facilities.

Considering the process of coal supply as a series of steps — mining, beneficiation (cleaning), transportation, and combustion or conversion — research and development in Ontario becomes relevant at beneficiation and increases through the subsequent steps.

Beneficiation

All bituminous coal companies in Canada operate coal-washing plants. Sub-bituminous coals and lignite are generally not washed, but are crushed, screened, and then put through a dehydration process. At present, bituminous coal-cleaning techniques rely on different combinations of gravimetric methods and flotation. Though some operators use thermal dryers, McIntyre Mines recently installed a HoloFlite dryer, a technology transferred from food processing. Canadian operators pioneered the application of 'water only' cyclones to treat oxidized western coals, which are difficult to separate by flotation.

Good results could be achieved without delay with more thorough cleaning down to finer sizes by applying known equipment and methods more intensively. Production of a range of coals from one bituminous coal mine is possible: first high-quality metallurgical coals for coke-making (achieved with a high reject proportion); then an intermediate-quality coal for steam generation in distant markets; and finally poor-quality rejects for power generation locally.

In this connection, Ontario Hydro is co-sponsoring with Stelco, the Central Electricity Generating Board of the United Kingdom, and the Tennessee Valley Authority, a pilot plant test at Lakeview aimed at achieving 'intensely physically clean coal'.

The drying and upgrading of lignite, which is high in moisture and oxygen (moisture contents of

FIGURE 15

Canadian federal funding of coal research and development, 1978-80 ($ million)

Topic	Funding
Gasification and liquefaction	2.174
Geoscience concepts related to coal resources	0.752
Coal resource/reserve assessment	0.095
Quality and quantity of coal reserves	0.886
Coal mining	0.842
Coal preparation - spherical agglomeration	0.160
Coal carbonization	0.568
Coal sulphur removal	0.125
Coal IEA agreements	0.395
Coal supply and materials research	0.035
Coal combustion - conventional technology	0.260
Coal combustion - developing energy technology	0.525
Material for fluidized bed combustion	0.214
Coal combustion - demonstrations of new technology	1.038
Total	8.069

Source: Office of Energy R & D, Energy, Mines and Resources, Canada.

20 to 40 per cent as mined are typical), is another important area of beneficiation research development. Conventional thermal drying can lead to severe dust and other problems in handling and to spontaneous ignition in stockpiles. Nevertheless, there is a strong incentive to reduce the moisture and other harmful components as much as possible to improve combustion and avoid unnecessarily transporting water. The moisture in lignite also causes it to freeze in rail cars.

The U.S. Bureau of Mines recently contracted for the development of a patented process of drying and pelletizing lignite, claimed to reduce moisture content from 40 to 10 per cent and double the kJ (BTU) content per unit of volume.

Soviet scientists have traditionally been very interested in the fundamental physico-chemical makeup of coal and have worked on a process for making 'thermocoal'. By heating lignite fines (particles), travelling at high velocity, with an oxygen-deficient gas in vortex chambers at 450 to 500° C, they have managed to eliminate oxygen-bearing ballast and moisture. Information is sketchy, but apparently the process has been pilot-plant tested and can be implemented at a production scale. The production of 'thermocoal' in the U.S.S.R. would make it economically feasible to move lignite products 4,000 km from Central Asia to Western Russia.

The short-term focus of much research and development in coal beneficiation is on the removal of sulphur from coal. Many novel methods, including microwaves and bacterial action, have been proposed and are under development. However, with current legislation and because of the existing investment in electrostatic precipitators, requiring a certain level of sulphur, further sulphur removal is, for the time being, not an immediate concern in Ontario. However, the research effort could result in cheaper methods of cleaning coal, with a higher proportion of coal being recovered and more ash and trace elements being removed.

Research on oil agglomeration, used for cleaning ultra fines (very small particles), is being renewed. Research is active in Australia, Canada, the United States, the United Kingdom, and West Germany aimed at recovering a useful low-moisture product from fine coal, improving the coking characteristics of fine coals, and treating non-floatable coal. Oil agglomeration will be studied in the Intensely Physically Clean Coal test facility at Lakeview Generating Station.

Eventually coal beneficiation could be aided by chemical cleaning methods. Spurred by concern over atmospheric emissions, sulphur removal is the primary goal of this research. No chemical beneficiation method has yet been applied on a commercial scale. Processes now under study appear expensive and will probably only be used in combination with conventional treatment methods on very high sulphur coals.

Coal washing facility at Lakeview Generating Station

Transportation

With the exception of slurry pipelines, developments in coal transportation will probably involve refinements and extensions of existing technology and management improvements, such as improved methods of train management, right-of-way improvements, and larger self-unloading ships. The importance of these developments cannot be underestimated. As noted earlier, slurry pipelines are unlikely to be of interest to Ontario in the immediate future.

Combustion

The combustion technology receiving the most attention in recent years is fluidized bed combustion, in which pulverized coal is burned in a suspended or fluid state by blowing air through it, permitting very efficient combustion with reduced stack emissions. Limestone can be added to the fluid bed to capture sulphur, thereby reducing sulphur emissions and allowing the use of higher-sulphur coal.

Using a form of this basic process called pressurized fluidized bed combustion, a utility could achieve improved heat transfer rates, less inherent pollution, and the ability to use a smaller plant for a given installed capacity. Small unpressurized units could be attractive for industries wishing to generate steam for internal use.

The largest known pressurized fluid bed combustor now operating is only 30 MWe, but installations twice as large are proposed. Units big enough to meet the needs of a utility like Ontario Hydro are some years in the future. But, as industrial-scale units are proven and become available, they could have direct bearing on decisions to substitute coal for other energy forms in space and process heat applications.

Other coal combustion developments that could have applications in Ontario include:

- the addition of pulverized minerals such as limestone during combustion to capture sulphur (currently efficiencies are poor and the system is fraught with problems);
- the combustion of pulverized coal-oil-water slurries, offering the potential for fuel diversification in existing oil-fired boilers (the Ontario Research Foundation has done some work in this area);
- the production of a stable coal-oil-water emulsion able to withstand transportation and storage.

Conversion

Coal conversion is a complex field involving several marketing choices. Coal can be converted to petrochemicals, transport fuels, industrial fuel gas, synthetic natural gas, and solid fuels. It may even be technically feasible to meet combinations of different user requirements in one process route. The necessary technology is at various stages of development, ranging from current commercial application (SASOL I in South Africa producing syngas and liquid hydrocarbons, including gasoline) to bench-scale testing.

Attention has focused on liquefaction for the direct production of liquid hydrocarbons from coal, and on gasification to produce low or high -kJ(BTU) gas. Liquefaction, at present, ranks ahead of gasification in terms of probable economics relative to other fuels in North America. The emphasis on liquefaction is heightened by the fact that Canada is more likely to suffer shortfalls of liquid fuels than of natural gas.

Current commercial processes for coal liquefaction have a thermal efficiency of 40 to 45 per cent; that is, the energy content of the liquid product is 40 to 45 per cent of the energy content of the coal from which it is produced. However, processes at the pilot-project stage have efficiencies as high as 65 per cent, and some experimental processes have thermal efficiencies in the 80 per cent range.

Roughly speaking, one tonne of coal could yield 0.28 to 0.44 cubic metres (1.75 to 2.75 barrels) of liquids. Commercial plants now being designed in other countries (principally South Africa) will produce about 7,950 cubic metres (50,000 barrels) of liquids a day. Each plant thus requires coal production of about 6.5 to 10.0 million tonnes a year or 200 to 300 million tonnes over the life of a plant, representing a scale of coal production far beyond that typical of Canadian mines.

Ideally, a liquefaction plant would be located at the mine site to minimize the cost of transporting coal. The number of Canadian coal deposits of sufficient size to support a liquefaction plant is limited; preliminary estimates range from 10 to 25. In view of the fact that the development of a mine of the appropriate scale would take seven to 10 years, it is unlikely that liquefaction plants would be operating in Canada on a commercial scale before 1990, however rapid the rise in price of other forms of energy.

Ontario steel-makers have an incentive to reduce the coke rate — another form of coal conversion. They have elected to improve efficiency and minimize coal supply and cost problems through the 1980s by optimizing conventional practices. Wholly new processes such as formed coke, are receiving less emphasis and are unlikely to be implemented until the economic advantages are clear and the risks minimal.

Innovations being developed to improve coke plant operations in order to manufacture coke of adequate quality, include selective pulverization with density control, preheating the charge, selective agglomeration, the use of anti-fissurant additions, and dry cooling of the coke. Also, coal injection into blast furnaces is being tested, and Stelco's SL/RN kiln uses sub-bituminous coal to pre-reduce iron ore pellets.

The thrust of these developments is to substitute lower-cost, more abundant, lower-rank coals where possible. In addition, these operational changes will give the steel companies greater flexibility in selecting their sources of coal supply.

Longer-term research and development is directed to coke-making from sub-bituminous coals — coals that today would not even be considered for blending. The production of formed coke (partially or fully carbonized coal briquettes that are mechanically shaped) has been studied and adopted elsewhere but does not seem particularly attractive for Canadian coals. While formed coke is applicable to low-rank coals, a low ash content is necessary. Canadian sub-bituminous coals are generally too high in ash and would yield too little sufficiently clean coal through intensive beneficiation to be attractive.

The Canada Centre for Mineral and Energy Technology and the Canadian Carbonization Research Association have studied the use of a fluid bed roaster to make formed coke. Another possibility is to extend the utility of indigenous resources by using some artificial material to substitute for low-volatile coal. Solvent refining of low-rank coal has the potential to produce an artificial material with good coking properties. Such a material may also be obtained from the residue after refining oil sands or heavy oils.

Conclusion

Coal plays a significant role in Ontario's present energy balance and represents a secure long-term energy source for Canada. Metallurgical coal will also continue to be a principal raw material of the iron and steel industry.

The extent of future coal development will depend to a great degree on research and development programs being conducted in Canada and throughout the world. Continuing progress in these efforts to overcome the negative environmental impact of coal, to improve coal transportation and utilization techniques, and to develop processes to convert coal to liquid hydrocarbons and petrochemical products, will contribute to unlocking the large energy potential of coal.

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